CHAPTER I

METAL INDUSTRY

One of the inner-most desire of man since ancient time has been to find suitable media to give expression to his creative imagination, novel ideas and aesthetic instincts. The main media are stone, wood, clay, metal etc. Stone tools were useful and durable but they could not enhance the productive forces. Wooden objects were perishable and could not keep the object of art alive for a long period. Clay was also not a durable material. Hence, metal was the most important and durable medium to express man's creative mind and aesthetic sense. Metal has remained a factor of revolution in the social and economic spheres of ancient, medieval and modern age. The earliest man mainly used stone tools, but along with the growth of civilization man started the use of metal which developed as a result of the technological evolution from one stage to the other. During early medieval period it had become a part and parcel of the production process. Metal industry has taken its highest rank among the industries of that period. It in Northern India, had become a fairly advanced craft as is evident from literary and epigraphic records of this period (600-1200 A.D.). It has been corroborated by the objects found in various excavations carried out at different sites in Northern India. It had effected the social and economic condition of
the period. Metals of various types such as iron, copper, brass, gold, silver, zinc etc. were used for making numerous objects for various purposes.

I Shapes and Types:

During the period under-study the artisans and craftsmen of Northern India mainly used metals for making tools, weapons, vessels, ornaments and other objects. It is quite evident from a gleaming of the contemporary literature\(^1\) as also an examination of the finds collected from excavations\(^2\) at various sites in Northern India. It is also noticed that the metal used by the community to serve most of their purposes was iron although others metals like gold, silver, copper were also infrequently used. These represent the aesthetic view of that age on the one hand and prosperity of the society on the other. It is well known that the development of arts & crafts and the socio-economic development of a society in any age go together. The progress of arts &

1. HCCT, PP-208, 212, 216, 227; BRWW, P-83; AP, 241, 251, 252; SSD, I, P-178; SN, II, PP-196-197; Yuktikalpatru, PP-170, VV, 24, 27, 29; DKD, PP-40-44, 54; KBS, P-147; TM, P-8; KR, PP-81, 161, 242; PPS, P-17.

2. ASSMR, 1902-03, PP-205-212; ibid, 1913, PP-50, 51; AI, P-61; EI, IV, P-126; IB, III, PP-123, 128; MASI, 55, P-83; IA, 1954-55, PP-42, 1971-72, PP-8, 28.
crafts involves expansion of productive activities of the artisans which in town lead to higher standards of life of the society of that period.

So far as development of arts & crafts as represented by the state of metal industry during the early medieval period is concerned its comprehensive picture can be drawn with the help of numerous references available in contemporary literature to this effect and the archaeological finds pertaining to that period collected from various sites of Northern India. In order to make a systematic study of various aspects focus is mainly placed on an analysis of technical evolution through a study of tool and implements, methods and techniques employed in making them, aesthetic quality of the products and position of the artisans craftsmen in society is based on literature & archeology. The metal most predominantly used by people in their daily life was iron. This metal was chiefly used for making agricultural tools and implements. Since agriculture was the main occupation of the community the blacksmith who made agricultural implements such as spade, sickle, axes, ploughshare etc. was considered an indispensable part of that community.

1. HCCT, PP-212, 227; KP, VV, 109, 117, 118.
Various literary sources and the archaeological excavations throw light on the various types of implements made by blacksmiths with iron. These are as under:

i) Agricultural Implements

Ploughshare

It was the pointed shoe in the plough. It was an important part of the plough. It made furrows in the fields and references to it are found in contemporary literature.

Hoe

It was an iron object used by the farmers for loosening the soil. Contemporary literature and the excavations at Bihar and other places of Northern India prove its presence. Iron made hoes of the Muslim period have also been found.

Sickle

It was a hook like implement made of iron and used for harvesting. This is also used in the modern age. It has been in use since the Vedic times. Fragments of iron sickle

1. HCCT, PP-212, 227, Smriti Chanderikā, III, P-279.
2. HCCT, PP-208, 212, 227.
5. Yajurveda 12, 68.
of the post Gupta period have been found in the excavations at various sites in India for example Gilaulikhera (Distt. Morena) in M.P.¹

Spade

It was an implement which was used for digging soil as is clear from its name. The land was prepared by it to make it suitable for agriculture.²

Axe

It was an object of common use. References to it have been found in the contemporary literature.³ It was generally for cutting woods and also during war.⁴ It was called Kulhārā in Vedic Literature and references to it are found in the works frequently.⁵ The archaeological excavations confirm this. A Nalanda seal depicts two men carrying axes which indicates the use of iron axes by the contemporary People.

1. IA, 1981-82, PP-33, 34.
2. HCCT, PP—208, 212, 227.
3. Ibid., P-226.
4. BRWW, P-83.
5. Atharvaveda, 3. 19. 4, Maitrāyani Upnīṣad 6. 33; ASIAR (1903-04) P-182 finding No. 743 (iron axe head); IA (1981-82) PP-33-34.
Amkuśa (goad):
This implement was in use during the ancient times.¹ Sometimes, it was used as a weapon but its chief use was made for leading elephants and the other animals doing agricultural work.

Hatchet:
It was a short handled light axe generally used by the farmers in agricultural work. In domestic affairs, it was also used to cut wood etc. It was a war weapon also as it was used to kill enemies².

ii) Weapons & Armour
It may be added here that all the above agricultural implements are used even in the modern times by the farmers of India, specially those who carry out the operations manually unaided by machinery.

The need of manufacture weapons of war on a large scale arose after the death of Harṣa in 647 A.D. which threw India in a state of turmoil fragmenting it into a number of smaller and mutually hostile states with no strong Central authority to control them and thus attracting the foreign

¹. Rīgveda, X, 44.9.
². AP, 252, SN; IV, P-212.
(Turkish) invaders in the Northern part of the country. Northern India had then made considerable progress in the field of metallurgy. Iron was the most common and useful metal used for war weapons. There is no references to new inventions and the same old weapons continued to be used as were used in the age of epics. These were spears, shields, bows, arrows, swords sabres, battle axes, lances, pāśa, gada, chakra etc. The references to these have been found in contemporary literature and this fact is corroborated by the archaeological excavations also.

Swords

The manufacture of swords was an ancient Indian industry as its mention has been found in the works of the ancient period. Many historians of the medieval times have mentioned it. Alberuni refers to the makers of swords in Northern India. The author of Śukranītisāra regards the makers

1. BRWW II, P-83; RT, VII, 792, 1505; Yuktikpātra PP-140-142; SN, IV 7.212; AP, 252.2, 6-8, 9-13; Matsya Purāṇa, 160.10; SSD, 31.107.
of swords as useful servants of kings.\(^1\) Utbi describes the use of white swords which means the best steel sword.\(^2\) Nizami in his Taj-ul-Massir describes the use of Indian swords by the soldiers of Gwalior.\(^3\) Native Indian Literature also mentions the features of the swords, made in various parts of North India along with famous manufacturing places such as Benāras, Magadha, Nepāl, Saurastra and Kalinga.

Chau-Ju-Kua states that the double edged swords of Bengal were very sharp.\(^4\) Swords, made in Khattara are beautiful, in Surparaka are strong and in Anga and Vanga are sharp.\(^5\) In the 11th century A.D. Bhoja describes the Anga swords as dirty and blunt.\(^6\) The distinguishing characteristic of good and bad swords was the sound produced by them. The Agni Purāṇa describes that the sword which is 1,50 angulas in length and produces the sound of an ornament was the best and the best types were those known as Padmapalasagra, Mandalagra, Karaviratalagra, Chritagandha and Akasaprabha. The worst type was known as Srngaradhara. Nine verses each of

\(^1\) SN, (Ed, Cal) II, PP-196-197.
\(^2\) HIED, II, P-33.
\(^3\) Ibid . P-227.
\(^4\) AE, 245, P-475.
\(^5\) Ray Niharanjan - Vāngalir Itihās P-182.
\(^6\) Yuktikalpatru, P-170, v.27.
good and bad swords have been given in S-r-ngārdhara. The sword which on being struck produced beautiful sound, was worshipped by Kings and the one which was curbed was to be thrown away. From the excavations at Maragada one sword belonging to the 12th century has been found which proves its existence in that age.

Bows

It was an armament used from the age of epics and in ancient period of Vedic age.¹ It was also known by various names such as dhanvas, Jayahroda². It was usually made of strong staff bent into curved shape. Its strings were made of hide etc. In the period under study, reference to its use has been made in literature³. Bows spotted with golden figures have been described by Bana in his Harsacarita. Sharp and pointed bows had been used by the infantry from ages. Agnipurāṇ states that the rod of the bow was made of iron. It was inlaid with round bits of gold, presumably to beautify it. Sometimes the bow rod was made of gold, silver, copper or black iron.⁴ The gridhpasksha named bows and pure

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¹. Atharvaveda IV 4.6; EI, I, 87, 132, 302, 312; AP, 245; AP, 245.4.
². Katyayan Sarusti Sūtra XXXII, 4.11.
³. HCCT. P-172 Sastri C.Śankar Rāma op.cit. PP-140-42.
⁴. AP 245, 4-9, P359.
iron made bows have been referred to in Śīṣūpālavadha of Māgha¹. From Jhunjhunu (Rajasthan) a bronze goddess, Achyupta, riding on a horse, has been collected. She carries a bow and shield in her hands.

**Spears and spear heads:**

Spears and spear heads were in use during the ancient times.² They were being used by the warriors. Alberuni refers to the occurrence of spear points in Northern India. Utbi says that soldiers of Brāhmaṇabāla, son of Ānandabāla used blue spears.³ From the Archaeological excavations in Northern India, the important finds include spear heads of iron which pertain to the early medieval period.⁴ The place of their excavation were Malhara Distt. Bilaspur (M.P.), Basarh, Kumrahār and Nalanda.

**Jevelin:**

It was called 'Tomara' and was also used as war weapon from the Ancient times.⁵ In the early medieval period, its

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¹. Tripathi R.P. Tr. Śīṣūpālavadha of Māgha, PP-479, 556; Watters, I, P-171.
². Kalpasūtra, XIX, 62; Jātaka No. 462.
³. HIED, II< P-33; AI, I, P-61.
⁴. I.A, (1975-76) P-23 (1974-75 IP-22; ASIAR, (1913-14) No. 185 finding No.5 (Spear head.)
⁵. Kalpasūtra, XIX, 53.
(Tomara or Javeline) mention is made.\footnote{A Pj 152.} It usually had a wooden body and metal head formed like a bunch of flowers and three cubit long. Long, sharp and pointed Javelins have been mentioned by Hieun-Tsang as described by Semuel Beul\footnote{BRWW, II, P.83.}.

Knife:

It was also military weapon and was also used in hunting\footnote{KSB, PP-73, 82;RT, VII, 927; KuttanImatam, 738-42.}. Alberuni says that they were manufactured in Northern India\footnote{A■I, I, P.61.}. This fact has also come to light from Indian excavations in Northern India at Basarh, Kumrahār, Bulandi-bagh and Nalanda\footnote{ASI (New Imperial series) No. Li.P, 100; ASIAR 1913-14, Nalanda Museum, Arch. No.32, 2862, IA (1975-76), P-76 (1981-82); PP-33, 34.}. An iron knife has been found at Manḍi, Distt. Dhar (M.P.). From the excavation at Gilaulikhera (Distt. Morena) in M.P. also a knife has been collected.

Arrows and arrowheads:

An arrow was an important commonly used armour. It was called Narachas also. Sharp and pointed arrows were used by the warriors. We come across different types of arrows which were made of iron\footnote{IA, 1971-72, P-28.} and some of them were silver. The

\begin{enumerate}
\item A Pj 152.
\item BRWW, II, P.83.
\item KSB, PP-73, 82;RT, VII, 927; KuttanImatam, 738-42.
\item A■I, I, P.61.
\item ASI (New Imperial series) No. Li.P, 100; ASIAR 1913-14, Nalanda Museum, Arch. No.32, 2862, IA (1975-76), P-76 (1981-82); PP-33, 34.
\item IA, 1971-72, P-28.
\end{enumerate}
silver arrows were used by the Kings and nobles. Some huge arrows were so destructive that they produced smoke and fire.

Armours:

Armours of metal (iron) were used to cover their body during war times as a means of safety by the soldiers. But the Kings and persons belonging to royal family used to wear armours studded with diamonds and precious stones and of gold. Gold and silver armours were also used by the nobles.

Daggers:

Daggers were also used in war. References to them have been found in ancient works also. People during early medieval period in Northern India used splendid long daggers. Daggers were fastened to the waists. In Kashmir men fastened the Kuthara (dagger) at the waist on the right side. Stone sculptures of this period show the presence of this war

1. AP, 245, 49, P-359.
2. ASI (New Imperial series) No. II P-100.
3. R T, I, 47, 107; Ibid, III, 792, GV, 493, P-141, SN IV, 10, P-68;
5. Jātak No.408; Kalpasūtra, XIX, 53.
Implent. A sculpture, showing a standing four armed Varahi, holding a dagger kept in the Allahabad Museum is a proof of the use of daggers¹. Pieces of iron dagger have been unearthed from Bihar excavations².

Shields:
Shields also come in the category of war weapons and were used for self defence³. Beautifully decorated and carved shields were used by warriors for their production as is depicted in the copper coins of Chandellas⁴. A small bronze image of goddess Achyuta riding on a horse, carrying a bow and a shield in her hands has been found at Jhunjhunu (Rajasthan) and pieces of an iron shield have also found Bihar⁵.

Quivers:
It was also a war weapon and was used by soldiers during war⁶.

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¹ IA, 1974-75, P-72.
² IA, 1961-62, P-4.
³ RT, I, 340-41, 362; Watters, I, P-17; BRWW, II, P-83.
⁴ Roy, P.C. - The coinage of Northern India, P-51.
Lances:

Lances were sharp and pointed war weapons. These were of two types as mentioned in the contemporary literature.  

i) Prasa:

It was a kind of lance which had a sharp razor like point.

ii) Bhindipala:

It was a small lance thrown by hand at the enemy in hand to hand battle. Some of the treatises give their names and technical specifications and also describe accurate modes of their use in the battle field.

Sabres:

It had a curved blade and used as a weapon of war. It was a kind of sword.

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1. BRWW, II, P-83.
4. BRWW, II< P-83, Watters, I, P-171.
Coats:

Coats made of iron were always used by the Kings to cover themselves in war time. Utbi says that soldiers of Brāhmanpāla son of Ānandpāla used yellow coats of mail (an armour of chainwork).

Poniard

Poniard was a dagger type weapon. Dandin, has mentioned a man with a poniard with its hilt set with jewels.

Gadā

It was commonly used during this period. It was also called mudgara (Gadā-mace) and was made of iron. Many heavy iron stuff gadās used by the guards, have been discovered in excavations.

Club

It was a stick made of iron used in fighting. Heavy weight club was called a mace. Contemporary literature mentions the club. These were used for physical exercise also.

2. HIED, II, P-33.
4. AP, 25, 11-12; SN, IV, 7.212.
5. IA, 1983-84, P-62.
Parasū:

It was an iron made battle axe and was used during war. Its use has continued through the ages. The sculptures of Śiva of early medieval period show parasu in his hand which reveals its use in war.

Noose

It was called pasa. It was made of iron. References to the use of noose as a weapon of war are found in Sukraṇītisāra and Nitiprisksha.

Chakra or Disc

It was also a weapon made of iron. The sculptors of this period depict this object in the hands of gods.

Darts

It was a weapon like a light jeveline and used by the warriors.

1. Yuktikalpatru, P-140; AP, 252.13, Nitiprisksha V 9.10; IHC session, P-257.
3. Yuktikalpatru P-140; SN, IV, P-216.
4. DKD, P-44; AP, 152.
Scoop

It was a deep shovel with a short handle and was used like a weapon.¹

Halbreds

It was sharp and pointed and was in use from the early ages. It was a kind of military weapon made of iron.²

Iron Chains

These were used to fetch the enemies and the culprits.³ Vākpati refers to creeper like chains of iron. It suggests the possibility of independent industry of chain production.⁴

Harpoons

It was a spear like weapon with rope attached to it. It was also used during this period as a war weapon.

Fire arms

It seems that fire arms were also in use during the period under study. Their use is suggested by description.

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1. **DKD**, PP-44-54.
2. **BRWW** II, P-83.
4. **IA** (1075-76), P-43.
Fire arms of five types (Āgneyastra) in Sukranīti. Medhāti-thi also observes that concealed weapons and arrows, poisoned or barked on with flaming shafts, were also in vogue but the Hindus denounced them on moral grounds. Prof. Dikshtai refers to tula gadā, aurva, nalikā, naračhi, agni-vāṇa and sataghni as fire arms.

The real fire arms were nalikās and Sataghna-is which were similar to guns and cannon. Sukranīti has references to the working of big and small nalikās. Some other fire arms were as mentioned below:

Light Machines were the apparatus which were used for continuous firing.

Cannon balls:

Cannons were big guns which were used to throw balls at the enemy. Balls were the bullets used in fighting.

2. Prof. Dikshtai - *War in ancient India*, PP-102-05.
3. SN, I, 239, 255; IV, 7, 192-208.
5. Ibid.
Tupak:

Tupak was also like a gun. Chand Bardai had used the word 'tupak' in the sense of small guns.¹

Sataghni (hundred killers):

It resembled a club in its movements and was shot out of other projectile weapons.² It was also taken to be a great cannon. It was pressed into service for protection of forts as Samrāṅgaṇāsūtradrāhāra clearly indicates that fire arms existed and were freely used in the war fire during that period.

Śula,³ Parigha,⁴ Bogs⁵ were other fire arms used by the soldiers during war.

Yantras:

These were installed in fortresses and were used for throwing stones. Right from the days of epics they remained in use and continued during medieval India.⁶ This fact finds

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3. AP, 252; Yuktikalpatru, P-140; SN, IV, 215.
4. Yuktikalpatru, P-140.
5. SN, II, 196-197.
From all that has been described above it is inferred that during early medieval period arms making industries functioned in different parts of the country and engaged a large number of artisans. Although workers used to produce the same old age weapons but product specialization in some cases must have proceed on highly competitive lines leading to much discovery and applied innovation. These factories were generally maintained by the Kings as has been described by the author of Sukranītisāra.²

iii) Household Articles

Domestic utensils needed for the purpose of cooking and serving food, were made of iron, gold, silver and mostly of copper and brass³. Copper vessels commonly used were sauce-pans, frying pans and spoons etc⁴. Varāhamihira has made references to copper.⁵ According to Puṣpa Neogi, the presence of copper ore signifies the fact that in ancient

2. SN, II, 198.
4. HR, I, P–178.
5. Brhatsamhitā, XLIII 46, L, 1, 17, 1, X, 5 etc.
India melting and casting operations were usually undertaken on the spot. It was required for coinage and for inscriptions, recording of the land grants and other transactions engraved on copper plates. Therefore, the demand for copper was heavy. Copper continued to be the most useful metal even in a later period. The Paharpur excavations in Bengal have unearthed many bronze images, copper bangles, caskets with a lid, cup, miniature bell and a flat rod.¹ Gold and silver were the other metals which were used for making the vessels of royal families and the rich.² Iron was also used for making various objects of daily use.³

The metallic objects unearthed at various sites shows that the iron industry was highly developed and many artisans earned their livelihood from this craft.

Thus metal Industry not only proved a boon to the agriculture and defence purposes, it also had a tremendous effect on the life of people of these times in their production of items of their daily use. The archaeological excavations at Basarh, Kumrahar, Bulandibagh, Nalanda etc.

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1. MASI, 55, P-85.
3. HCCT, P-208; SN, IV, II, P-214.
also provide evidence about the variety and numerousity of items made of metals used by the people of that age. Some of them are described below:

**Spoon:**

It was a commonly used article in the household. Golden spoons were used by the royal families and the richer section of society. Silver spoons were used by the nobles while copper spoons were for the common people. A spoon of iron found during excavation of a site is now preserved in Nalanda Museum.

**Jar**

It was also a household article and was made of various metals. The rich community used golden and silver Jars. These were considered a mark of auspiciousness. The Naisadh-charita refers to bhṛngaraka, a golden Jar, circular in shape. The existence of jars of metal during early medieval period is proved by archaeological finds also. For example,

1. *ASIAR*, (1913-14) PP-160-172, Nālandā Museum Arch. No. 26, 1659 (lock); 32, 286 (Knife) m25. 1203 (Spoon) 16, 327 (Pincer) etc.
2. *HDS*, II (Part-I), PP-229, 231.
a copper jar containing fifty seven bronze, copper and iron objects was discovered at Hansi, Distt. Hissar (Haryana).¹ These objects pertain to the 7th-8th century A.D.

**Dishes**

It was a shallow flat bottomed vessel, used for holding and serving food at meals. These were made of copper and alloys such as Kāmśya (made from the combination of tin and zinc) and pitala (made by mingling copper and zinc).² But dishes of gold and silver were used by the Kings and nobles for taking their meals.³ Both Kṣemendra and Kalhana have referred to it. Golden dishes presented to Buddha as an offering by King Silādītya have been mentioned by Hemchandra.⁴ Thālam (a big dish) and thāli (a flat dish) have been referred to in Ākhyāṇakamaṇḍikosā.⁵

**Cups**

The common people used only earthen cups. Bejewelled gold and silver cups were used by the Kings, nobles and the

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1. IA, 1981-82, P-91.
4. TSPC, PP-400, 413.
affluent section of the society.¹ The Pāhārpur excavations in Bengal have unearthed a copper made cup which proves existence of these pieces of household articles².

**Bowls**

Bowls were used for drinking liquids. King Avanti-Verman (A.D. 855-56-883) had silver bowls with the engraved names of the erstwhile Kings or rulers³. Round bowls (kunda) were made during 9th century A.D. Bāṇa mentions a bowl decked with lotuses and silver Varao i.e. a bowl and maṇīkā i.e. a wine bowl.⁴

**Frying pans**

Frying pans were mostly made of iron. This craft was very extensive. Besides iron, other metals such as copper and Pitala were also used, though rarely, to make frying pans.⁵

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¹. KM, IV, 13, P-68; NC, XVI, 99; RT, VII, 265.
². MASI, 55, P-85.
³. RI, I, PP 164, 187, 199.
⁴. HCCT, P-131; NC, XXII, 144.
⁵. Acharya Śrī Hemchandra, op.cit. PP-400, 413; HCCT, P-208.
Pitchers or Water Vessels

We come across water vessels made of gold being used by the royal household. Both Kṣemendra and Kalhaṇa have recorded that for storing water for Kings and nobles golden pitchers were used. The Edilpur plate of Keśavasen mentions iron pitchers. Thus, it is found that pitchers were made with different metals for different classes of people.

They were used for drinking and keeping water etc. These were made of various kinds of metals such as copper, silver and gold etc. Gatantika, probably water jug has been mentioned.

Simmering pans

It was an iron object used for boiling or to keep boiling the household items.

Sauce pans

Sauce pans were generally made of copper and iron which were used for keeping the sauce.

1. KB, P-18; RT, VII, 265; Paumacariu, II, P-108; ibid, BP-406; Acarya Sri Hemchandra op.cit. PP-400, 413.
2. IB, VII, PP-123, 128.
3. NC, XVI, 84.
4. HCCT, P-208.
5. Ibid.
Ovens

Ovens were used for cooking food and to purify gold etc.¹ and Pan (tavā) was used for cooking bread.²

Buckets

Iron buckets were used for drawing water and keeping in them.³ Other household objects were: spouted lotus made of copper, ewers (like lota or a water jug) and meals tray etc.⁴

Urn

It was a vessel with a tap in round or angular shape. Two small copper urns have been found from the excavations at Bhoja caves.⁵ These were kept in the circular stone with hollow space in the centre and covered at the top by a piece of gypsum.

Vessels

These were made of different metals and were used for various purposes. Silver vessels were used to pour milk for

1. Ibid; TKC, 1,6,3,P-154.
2. IA, 1975-76, P-76.
4. IA, 1983-84, P-95, LHT, PP-173-177, PPS, P-17, Paumacariu, IV, 73, 5, P-302.
5. Jas Burgess and Pandit Bhagvan Lal Indraji—Inscriptions from the Cave temples of Western India, P-57.
the bride and bride groom. These vessels are still used during marriage time. Brass vessels were used more commonly by all classes of people. Hieun-Tsang has recorded the exquisite craftsmanship of gold and silver vessels. Dhupa-graha was a censer or an incense burning vessel. Katha was a hollow vessel which was placed above a lamp with its mouth downward to accumulate soot for the purpose of preparing collyrium. Even today the village women prepare Kājāl in the same way. Silver vessels were also in vogue.¹

Boxes

These were used for keeping clothes, ornaments, other valuable possessions and such other things which were required safety and cleanliness.² Various types of metals were used in making boxes of numerous designs such as iron, silver, copper, brass and gold. They were sometimes jeweled.³ Ordinary men used iron made boxes. The Pāhārpur excavations in Bengal have unearthed a casket (a small box for keeping jewels) with lid.⁴

¹ HCCT, PP-99, 131.
² Acharya Śri Hemchandra: -op.cit. PP-400-413.
³ HCCT, P-131; Dutt M.N. - Vishnu Purāṇ, P-288.
⁴ MASÍ, 55, P-85.
Cases

Cases were used for keeping valuable records and a number of cylindrical copper cases were found from the excavations in Northern India.

Lamps and lamp post

Lamps were generally made of iron and were used for light. Along with iron, copper was also used for making these objects. From the excavations at Ballal Dhipi Distt. Nadia (West Bengal) copper lamps have been found. A large lamp of iron slag has also been found from Maharashtra (600-800 A.D.).

Lanten (for light) and Fan post (with iron boundary which made it strong and beautiful) etc. were other objects used in this period.

iv) Manufacturing Tools & Machines

Fine iron instruments which were used by the blacksmiths, coppersmiths, carpenters, sculptors and the architects were also made of iron. In the epigraphs, mention of Lohar i.e.

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1. IA, 1983-84, P-95.
2. Ibid.,
4. DKD, (Notes) P-74.
blacksmiths have been made. The instruments were:

i) Needles.

ii) Razors (used by the barbers).

iii) Wrench (a tool of screwing).

iv) Tong (chimtā) an instrument for grasping and holding things.

v) Trowelers (a tool of masons's used for spreading mortars).

vii) Tweezers (for plucking up small objects).

viii) Chisels of different types.

ix) Pincer (an instrument, preserved in Nālandā Museum).

x) Scissors (used by the tailors).

xi) Saw (an instrument with toothed edge used for dividing wood, metal or stone. It was an iron made implement and was used by the carpenter usually, as described in Amarkośé.)

1. EI, IV, P-126; IA, XLI, P-20 fn.
3. KM, IV, 3, P-64.
4. DKD, PP-44, 54.
5. ibid, IA (1954-55) P-24.
9. IA, (1975-76) P-76.
xii) Hammer was (an iron made instrument used by the blacksmiths.\(^1\) The goldsmiths used a small hammer and the same has been found in excavations\(^2\).

**Machines and Machinery:**

Various kinds of machines made of iron were used by the professionals in various industries.\(^3\) Engines were also made of iron.\(^4\) As per description given in contemporary literature machinery was used for:

i) Drawing water\(^5\) ii) extraction of oil\(^6\) iii) Pressing barley iv) Stone cutting v) making of watches and musical instruments vi) making of ivory objects\(^7\) and silver products etc.\(^8\)

v) Other Metal Artifacts

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1. Paumacariu, II, 31, 5, P-175; *ibid.* III, 55, 6, P226.
3. NC, X, 6.
4. EI, I, P-287 fn. v. 26 & also note IV on, P-289.
5. RT, VII, 1232.
6. EI, XXVIII, 244; XIII, 139; EI, XI, P-41; I, P-173 fn.
7. E.I., X, Bhatera Copper Plate line 5.
8. EI, XXI, 96; SN, II, 198, P-86.
(A) Objects used for seating and bathing:

Thrones:

Thrones studded with jewels were for the kings. Mānasol-lāsa mentions golden lion thrones.

Pedestals

Pedestals of metal were used for bathing. For example, king Avantiverman (856-883 A.D.) had three pedestals made of silver.

Stools of metal feet

Though stools with iron feet were common use but the Kings, queens and other royal personalities used golden feet stools. The Couches jewelled with ornaments were used by royal families.

(B) Metal objects used for buildings and in their construction

Dowels

Dowels of iron were used for joining together the big stones. Masons of that period used them in the construction

1. KSS, P-127.
2. RT, I, 192.
4. KSS, P-173.
of houses, shrines etc.\textsuperscript{1}

**Rivets:**

Rivets were bolts used for fastening together two pieces of metal.\textsuperscript{2} Iron rivets were applied in strengthening buildings from top to bottom. Tārikhā-ī-Yamini informs that on both sides of Mathura, there were a thousand houses to which temples were attached all strengthened from top to bottom by iron rivets\textsuperscript{3}.

**Folding house:**

Folding house of silver measuring thirty by fifteen yards had been found by the King Sultan Mahmud among the plundered things from the fort and temples of Nagarkota\textsuperscript{4}. It shows the artists skill of that age and also the prosperity of the country.

**Bar (Arglā):**

It was used for closing the doors. Locks and keys along-with Kulakas, door chains, hinges were also used in the

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\textsuperscript{1} Ronald Benjamin - *The Art and architecture of India*, P-118.
\textsuperscript{2} PIHC, 10th session, P-254.
\textsuperscript{3} HIED, II, 44.
\textsuperscript{4} Ibid, II, 35.
doors and windows.¹

**Beams:**

Iron was used for various purposes during the period under survey. Its special use was in building and temples. Indian Engineers also planned the manufacture of about 239 beams all long as 17 feet and up to 6" by 4" or 5" by 6" section which have been used in the Gundichabari.² Graves gives a detailed description of these beams. As many as 95 beams were fixed at the lintels of doors and 114 below the temple. Iron beams are also seen in the Bhuveneshwar Temples. Percy Brown observes that beams were forged and the larger ones were evidently produced by welding together a number of beams of wrought iron by means of hammer.³

**Poles:**

Poles were used for canopies and were made of iron. But in royal palaces, golden-poles were used.⁴

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Golden Parasols:

Golden parasols were placed on the top of the temples of Hindu deities.

Roof of the shrines:

These were adorned with golden cups by the Kings. A King Kalsa (1063-1083 A.D.) had founded a temple of Śiva Kalaśevara whose roof was decorated with numerous golden cups (ghati).

(C) Miscellaneous Objects:

Crucibles:

Crucibles were the melting pots made of iron. These were twelve cubits long. Regarding the ingredients for these, Vāgbhaṭa recommends that the earth which was heavy and of a pale colour, sugar or earth from an anthill or earth which has been mixed with burnt husks of paddy, fibres of hemp plant, charcoal and horse-dung pounded in an iron mortar and also rust of iron, are to be used for making the same. Rasa-

1. Ibid. II, 264.
2. Ibid, I, 310.
ranava and Rasaratnasmuchchaya have described the making of Jaranaya Yantram. Crucibles of post Gupta period have been found from the excavations at Delhi.

Mortar

Iron mortar was used for crucible making.

Furnaces

Furnaces were apparatus as used for melting metals. Rajput-period made furnaces have been found in the excavations in Northern India.

Chariots

These were used by the people of that period. The royal persons used chariots with gold steads. Iron made chariots with petty golden belts were for war.

Cages

Generally iron cages were used for keeping birds and animals. Tigers were kept in cages. The Queen Kādambarī had a cage of golden bar.

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1. Rasaranava, IV, P-7; Rasaranasamuchchaya, X, PP - 5,6.
2. IA, (1969=70), P-22.
3. Ibid.,
4. DKD, P-22.
5. Kā. Ridding, P-8; Mirashi V.V. - Bhavabhūti, P-164.
Drums

Drums were generally made of iron but golden drums have been made to beat during the march of Kings. Golden drums were beaten with strikers for every step when king Ḡilādataya marched\(^1\). Drums were used as a signal of the beginning of war\(^2\). Damarus was also used as the drum of war.

Sticks

These were used for stroking the drums\(^3\).

Handles of fly whisks (Camaris)

Camaris were used as fly whisks. Generally these were made of wood or baser metals but in the royal court, the golden handled camaris were used.\(^4\)

Iron Shoes

Iron shoes of horses were also in vogue as mentioned by Damodar Gupta (minister of Jayapīd 774-813 A.D.).

Fetters of iron

These were put on the feet of the enemies who were taken captive.\(^5\)

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1. LHT, P-173.
2. PCM, P-71.
4. DKD, P-114; KB, P-98.
5. HCCT, P-95.
Staffs

These were used by the king and rich persons. These were usually made of gold. The common people used iron staffs. From the excavations of Maragoda Distt. Kala\text{\text{"}nadi (Orissa) three pieces of heavy iron staff used by the guards have been found.}

vi) Seals, Coins, Images and Idols:

Seals

Seals in huge quantity have been discovered from various excavations. A golden seal of king Hars\text{\text{"}a having a bull figure and a copper seal of the same figure have been found at Sonepat.

Coins

A number of gold coins have been discovered in Bengal which belong to 600-1200 A.D. Although these are on the pattern of the Gupta coins yet they reveal the artistic skill and sense in their engraving. R.Burn attributed a few silver coins to king Harsavardhana. Thus the use of gold

\begin{enumerate}
\item HCCT, P-124, HR, I, I.P.-21, II, PP-52, 61; LHT, P-178.
\item IA, 1983-84, P-62.
\item IA, 1983-84, P-13, IA, (1966-67) P-75.
\item Allan, J. - Catalogue of coins P-CXXVII.
\item JRAS, P-843; Mukharji R.K. - Ancient India, P-360.
\end{enumerate}
and silver was not limited in spite of their cost and they offered ample opportunity to the intrinsic craftsmanship of the artisans who had specialized in these metals. Gold and silver coins were minted at different places assigned by the Government. Copper coins were made by the rulers of Northern India, in various designs and in huge quantity. Coins of various metals have been discovered from the excavations.

Animal Figurines:

The contemporary literature as well as the archaeological excavations give us a vivid picture of the use of metal for making animal figurines. A detailed information is supplied in the Architecture on Mānsāra. Golden and Silver elephants (fixed on the cardinal point), iron made figure of sheep (in the south east), silver made hippopotamus (on the West), iron made figure of antelope (marked on the north), silver bull (on the north east), a frog of silver (on the cardinal point in the east), a fish of silver (on the north), a tortoise of silver (marked on the south cardinal point) and carti figure made of gold have been described.


Images and idols of metal

The metal industry had attained a great height during this period which is reflected in the production of Images of gold, silver, copper, bronze, brass and iron. Although the images were made of all kinds of metals yet most of these were of copper and bronze.

Bronze images

An image of goddess Achyupta (in small size) has been discovered from Svetāmber temple Jhunjhunu (Rājasthān). She is riding a horse and carries a bow and a shield in her hands. The pedestal of the image bears some vertical letters suggesting early Pratihāra Period (7th-8th century A.D.).

The bronze images of Vishṇu and a standing Buddha of the Pāla period described in literature clearly show the great advancement of the metal industry during 11th century A.D.

Fifty seven bronze images, mainly of Jain tirthankara ranging from 7th-8th century A.D. to 13th century A.D. have


3. IA, 54-55, P-24, Sahai, Dr. Bhagwant - The inscription of Bihar, P-91.
been found in a Jar, discovered at Hansi (Haryana)\(^1\). All these images depict the artistic talent of metal workers and the development of metal industry.

**Brass Images**

Not only bronze but brass was also in great use for making a variety of images of Hindu gods and goddesses. A lucid description in literature and the archaeological findings show that brass and copper were popular metals for making images.

Two images one discovered at Thaneswar of Chakraswami and the other image of Buddha, at Nālandā are of Brass\(^2\).

**Copper Images**

Copper industry was a flourished industry specially in Bihar and generally in Northern India. The important centres of copper images were Nālandā, Kurkihāra and Chandankeyari in Bihar. Hieun-Tsang mentioned a copper statue of Mahēśwar. As described by him the height of this statue is hundred feet as which proves the genius as well as the skill of the Indian coppersmith.

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2. BRWW, II, P-45.
Heiun-Tsang also saw a huge copper image of Buddha at Nalanda which was eighty feet in height. This image was housed over a pavilion in six stages. Though it was incomplete at that time yet according to its plan its height was to be hundred feet or more when completed. This colossal and massive structure was only possible in an advanced stage of metallurgical and industrial development.

One image of copper Buddha has been found from Sultan-ganja District Bhagalpur. Its height was seven feet and half an inch.

Two Copper images of Goddess Sarwati pertaining to the 10th, 11th century A.D. were recovered as treasure trove from Bhuj, Distt. Kutch.

From Kausâmbi copper image representing a head of a small Buddha has been found.

The copper cover of an image of Surya in Bhagalpur District has an inscription engraved on it. The inscription is

1. LHT, II, P-174; Watters, II, P-171.
2. LHT, P-119; THT, II, P-171.
3. IA, 1977-78, P-64.
4. IA, 1972-73, P-69.
engraved in a single line running along the circumference of the metal cover which shows the accomplishment of artistic skill in metal Industry.1

A few iron images such as a rare image of Surya and an idol at Somnath Temple were also constructed during this period.

Images and Idols of gold and silver

Gold was abundant in India as is mentioned by Hieun-Tsang. Gold and silver industry flourished during this period and many images made of gold and silver are the specimen of this industry. A separate class of goldsmiths used to make gold images. Due to fantastically expensive gold images, the Muslim invaders of this period made them special target of attack on Hindu Temples. In the Somnath temple the image of Siva attracted the attention of Mahmud of Ghazni. Kalhaña referred to idols made of gold and silver which were appropriated by the rulers to meet financial exigencies.2 Tabaqat-i-Nāsirī reveals that in the temple of Mathura, there were five gold idols. Out of these, one was five yards in height. The eyes of one of them were formed of two rubies and the eyes of another were formed of

1. Sahai, Dr. Bhagwant, op. cit., P-110.
two sapphires¹. Some other images were: Two golden statues of Buddha¹² (one in life size),³ Sun Deva image (cast in yellow-gold)⁴, red gold idol⁵, golden idol of Mahāvira⁶ and one gold plated metal image of goddess Chandi of Pāla dynasty (8th-11th century A.D.)⁷. P.K. Achāṅga has described a golden Phallus. Its altar was made of gold, furnished with jewels or alone with gold and that is why it was called Svarga (golden) Phallus⁸.

iii) Ornaments:

The demand of gold and silver metals in this period was great because of peoples' fascination for jewellery. Gold, Silver, Copper and other metals were abundant in India⁹. Reference to a Goldsmith has been made by Varāhmihira¹⁰. Gold and silver mines were worked to meet the needs of the royal sections and nobles. The fondness for ornaments was so

1. Tabquāti Nasirī, P-85.
2. LHT, PP-213-214.
3. Dutt, R.C., op.cit. P-142.
6. TM, P-275.
7. Sahai, Dr. Bhagwant and J.C. French op.cit. PP-38, 58.
high amongst the people that there was hardly any part of
the body left without decorating it with them, if possible¹. The lexicons inform about a large number of orna-
ments, their various types and designs. The varieties were
named after their characteristic features, their
workmanships and their shapes. Most of the ornaments enumer-
ated by the lexicons have been mentioned both by the foreign
and the indigenous writers of this time². Alberuni, who was
in India in 1030 A.D. has informed about the wide popularity
of ornaments among the people. He mentions that the men were
fond of wearing articles of gold ornaments i.e. ear rings,
arm rings, gold seal ring on the ring finger as well as on
the toes of the feet³. Early Abu Zaid said that the Kings
of India were accustomed to wearing ear rings of precious
red and green stones⁴. The Kings wore various types of
ornaments and the queens also adorned themselves with

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1. Nāgananda, II, 13; Ratnāvali, I, 17, PP-67-70; Kad, Rid-
ding, P-87; HIED, I, P-11; AI, I, P-181; HB, I, PP-
31-35.
2. KM, PP-20, 23, 49-50, 58, 75, 96, etc.; Mānasollāsa, vv
1049, 1129, 1163, 1177; Rāmacarita, III, 33-34; Deśinā-
mamālā, III, 8, I, 110; RT, VIII, 1232, AI, I, P-181,
TSPC, I, 229; Narmammālā, I, 144; Śāmavamatrkā, VIII, 14-17.
3. AI, I, P-181.
4. HIED, I, P-11.
them. Rajasekhara, Kalhana etc. refer to girdles, Kundalas, various types of necklaces, bracelets, ear rings and anklets.

Goldsmiths or industry of ornaments making flourished under the royal patronage because the rulers and ladies of their palace needed the services of goldsmiths of high skill and workmanship. The royal and affluent families adorned themselves with gold and silver ornaments whereas the poor satisfied themselves by wearing the ornaments made of copper bronze, iron etc. The metals were fabricated to fashion them into ornaments mainly of the following popular types.

Ornaments of Head and Forehead

Chudamaṇi (a gold ornament for head studded with gems and jewels), it was also called Chudā ratna; Lalīka (it was a gold chain or band which was put on the forehead; Hansati-laka, Benda (it consisted of a round pendant with floral design worked out in precious stones); Chalvaso (A head

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2. KM, PP-20, 23, 49, 50, 58, 75, 96, RT, III, 326, IV, 720; Samyamātrakā, I. 14, II. 70, III.37, VI.6
4. NC, XV, 32, ibid, XXI, 44,47
5. KSTS, P-150.
ornament which was popular among the people of early medi­ eval period); Gemdecked caps (worn by the noble and royal personalities); Diadem (the arch of a crown); Mrgashekha (It was an ornament of white colour, shaped in curve); Patra Pasa (a jewelled net spread over the forehead); Kirtilkuta (A head ornament with ornate triangular projections); Crest Jewels (The bride wore this on forehead) the ladies usually put it on in their parting of hair; Makara ornament of angular points adorned the forehead of the maidens; Richly decorated crowns often engraved makara. This motif was very popular among the kings; Smantabhushana or Chugama (It was a signifying crest jewel also used in modern India); Borla (was a crest jewel of ancient India); Bala Pasya (a jewelled hair net

1. Desanimamalâ, III, 8.
2. BRWW, P-75.
3. RT, VII, 195.
6. KB, PP-242, 244, HCCT. P-262, Samarricccakahã, PP-75, 78.
7. KB, PP-269, 178, Matsya Purana, 261.41.
called paritathya also); Garlands having golden ketaka leaf\(^1\) and Svastikas were the ornaments which adorned the head of the people of this period\(^2\).

**Ear ornaments**

Ear ornaments were the most important pieces of jewellery which enhanced the beauty of the face and for which ears were to be bored\(^3\). There were a large variety of ear-ornaments and more than one type was worn at a time. Not only females but males also decked their ears with ornaments\(^4\) \(^5\) \(^6\).

A general practice was that the people wore this ornament in one ear only leaving the other bare\(^6\).

Another special feature was the use of asymmetrical ear-ornaments. Two different ornaments were put on the two ears, sculptural evidences as well as excavations confirm this\(^6\).

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1. RT, I, 35.
2. Priyadarsikā, P-50.
4. EI, I, P-92, SP, II, 5, II, 5, Ratnāvali, II.
5. KB, P-38, HCCT, P-215.
The most favourite design was the fish or crocodile like design which is called Makara design1. Foliage motifs were also current². The following ear ornaments were in vogue during the period under survey: Kokurut (it was worn upper part of the ears of women);³ Karnika (it was an ear pendant shaped after the seed vessel of lotus); Kundala (it was an ear drop popular among the males and females. It has various types such as: i) Karnavatamsa ii) Talapatra iii) Uttamsa iv) Avatamsa v) Karnavali vi) Karpura vii) Dantapatra viii) Karnapasa and ix) Ratnakundla).

In addition to the above ear ornaments ear ring was another type of ear ornament most commonly put on by both sexes. Royal families usually wore golden ear rings set with pearls and precious stones* . The archaeological excavations confirm this fact⁵. The varieties of ear rings were: Crocodile (Makar)⁶ shaped; Cup shaped earring (worn by the Raj-

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2. Ibid.,
puts generally)¹ ; Round pressed square block ear ring² ; Heart shaped and Sīspataraks³ ; Tadiyagam and Tadidala; ringlets⁴ ; Kaṇakandi (plum-shaped small drop⁵ ); Tatānka (it was an ear lob like the wheel chakra made of gold mostly⁶ ; Dandaḍaka (A circular ornament consisting of pearls)⁷ ; Chudibhūsana (It was an ear ornament made of gold flowers of rubies, Nīlam and pearls, strung together)⁸ ; Kaṇakpatra (Gold leaf for the ear)⁹ ; Lotus and wheel design ornaments in copper and bronze¹⁰;

Discus (jewelled discus worn by the bride¹¹); Trinkets¹²; Ear tops¹³; Tadānka¹⁴; Dantapatra¹⁵; Kamyyadi¹⁶; Sravaṇapa-

⁴. DKD, P-107.
⁵. Kuttanīmatamkāvyā, 352.
⁷. Ibid, vv. 1102-05; Ancient India No.4 P-143.
⁸. Ibid. v. 1106.
⁹. Bilhaṇa-Chaurpanāchasīka, 79.
¹⁰. Report on Kuṣmrahār excavations, P-130.
¹¹. Samaraiccakahā, PP-75-78.
¹³. Patna Museum arch. No.9595.
¹⁵. TM, P-301.
Ornaments of Neck (necklaces)

Necklace was the most famous and commonly used ornament. Necklaces made of gold, pearls etc. wore women especially by the royal families.

The upper part of the body of the male and female was adorned with various ornaments round the neck. Men of all sections of society used necklaces. Women were also not behind in their fascination for them. For an artistic effect necklaces were usually studded with precious stones. The Dhāra inscription also gives names of various kinds of Hāras necklaces like Jalakanṭhi (the plain necklace), Ekāvali, Sonjāla and Chanchala hāra whose pendants touched the nābhi. The varieties of necklaces were: Necklace of floral design, Chandrahāra (shaped like half moon), pla-in Necklace, Stringed necklace, (Necklace having various number of

1. TM, P-226.
2. Ibid, Pāiyalacchīnāmālamālā, P-6, v.52.
3. Bhartihari-Nītisātaka, II, Narmamālā, I.114; RTV, 257, 356-69; Sāmayamātrkā, 11.51; 70, 73; VIII.34; TM, P-180; Ratnāvalī, PP-77, 140, 214; KM, PP-58,75, 96 etc.; Kut- tanīmatam, vv 297, 740, 987; Rāmācharitam, III, 33-34, P-72.
6. Ibid, TM, P-301.
strings from two to seven), Tyre-shaped necklace, jewelled necklace, Necklace stringed with tiger's claws, Tittibhaka (a necklace of two tittibhaka birds facing each other), Torque (a necklace of twisted gold wires), Necklace with central gem and pure pearls of round and big shape (used by princely families) and Rectangular slab arranged necklace. Necklaces with intricate designs such as lotus shoots were also manufactured which reveal the high degree of skill attained by jewellers, Hansali like necklace, Crest-shaped necklaces (the fine specimens of jewellery) all show the high skill of goldsmiths. There were also necklaces made of round coin like pieces, Kachavartakama (a coarse and cheap necklace), Mukutavali, Muktahara, Nabhackracumbanohara (the string falling down to the naval) ekā-

4. Ratnāvali, P-164.
5. Patna Museum Arch. No.7770 (See Pl.19) KSTS, P-153.
6. KB, P-243; KM, PP-58, 75, 96, Kāvyamāṇī, P-8.
10. TM, P-158; Naṅgananda, II, 12; Ratnāvali; PP-25, 276, 318.
vali and Krauncamāla.

Necklets:
These were closely fitted around the neck and did not dangle below. Their various forms were: Kanthi sūtra, locket (A metal plate), Jhālarā, neck ornament having bells of small size and made of gold and precious collars (neck band).

Ornaments of arms and wrists:
The use of armlets for adorning the arms was widely prevalent. Various kinds of armlets were worn by both the sexes such as bangles, armlets, Keyurs, bracelets etc—studded with precious Jewels. The noteworthy ornaments put on arms were: Angada (a circular ornament made of a thin rod of gold

1. Ibid, P-115.
2. Ibid, P-120.
5. Sharma, Dr. Dashrath – Rājasthān through ages I, P-464.
8. Kuttan Imatam, PP-57, 87, 193; GV, p146 (509) KM, P-83, HCCT, PP-117. 156, 197, 231; KB, P-102; Rāmacaritam, II< P-34; Paumacariu, II, 41, 4, P-354; Priyadarsikā, P-50.
with its ends resembling a lion's face)¹, a Valaya (It was similar to modern kankag used by all sections of ladies)², Armlets with fish motifs, foliage motif and snake-motifs (these were the products of skilled goldsmiths who introduced new designs and varieties according to the demand of the society)³, Makara designed gold armlets⁴, Intricate designed armlets, Ketaka (an ornament of fore-arm, set with rubies and diamonds)⁵ and Chudaka (it composed a number of bangles and divided into two parts, each connected with the other by means of their pins)⁶.

Bangles:

These were very popular ornaments of arms. Women had great fascination for them and thin bangles were popular among them⁷. The ladies of royal and noble families and richer sections used gold and silver bangles, while copper, bronze etc. were used for making bangles for ladies of the

2. AMK, Introduction, P-24; KSTS, P-153.
3. KR, PP-10, 16, 156.
poor sections¹. The existence of the bangles has been confirmed by Archaeology². Clasp of various metals, shaped like a flower, Valyakalapi (a special type of armlet having the face of a peacock and moon-shaped end³), Kada⁴ (it was put on arms and made of various types of metals according to their social status), Armbands etc. are some variations of ornaments put on wrists and arms.

**Bracelets:**

These were worn on the wrists and both the sexes liked them. The ladies wore these for fashion and for religious purpose as these were the sign of their married bliss⁵. The literary works and archaeological excavations describe various types of bracelets:

Barrel-shaped bracelets with crisscross design having four or five inches width were in common use⁶.

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1. IA, 1971-72, P-28 (copper bangles have been found from the excavation in M.P.)
2. NM, 56. 158/1 and 56.158/2; Nālandā Museum, Arch. No. 512/87; ASIAR, 1913-14 Kumrahar excavation have yielded a number of wrist bangle of metal.
5. NM, 59, 134; Nālandā Museum Pl. 23, 35.
Other varieties of bracelets in use were:

Bangadi, Maqibandha-kalapanka¹, Daman (stringed bracelet)², Avapaka, Parihārya³, and Keyūra⁴. Keyūras were of numerous types put on by both the sexes as the Pala sculptures have displayed. The main variations were:

Mukūṭa type or Mayurd-Keyūra (It was shaped after a crown or a peacock feather and was most popular), Keyūra with Kirītmukūṭa design⁶; Sarpa-Keyūras⁷, (The favourite ornament worn by both sexes). The images found by excavations pertaining to the period under study represent these ornaments.

Ornaments of hands (Fingers etc)

2. Ibid, P-500.
5. Nālandā Museum Pl.17, 23 to 25, 27, 35.
6. Sheo Bahadur Singh - Brāhmaical icons in Northern India P-150.
7. NM, 61.484, L. 143; A gold ornament of this kind, called Tadā is even now used by the people of Rājasthān.
Rings

Various kinds of rings studded with diamonds, rubies, pravāla, mārakata, puṣparāga, vajra, nīla and other precious stones were used by both the sexes¹. Some important varieties of rings were:

Uramika (was a kind of ring which was used only on special occasions²),

Rings of gold (set with pearls and precious stones adorned fingers of the kings)³.

Navagrha (A ring with gems set in whose shapes varied according to the designs)⁴.

Seal rings (angulimudrā) Golden seal rings were worn on the ring finger as well as on the toes of feet⁵.

5. RT, I, 181.
Trihlraka (It was a ring with a big diamond between two small diamonds).

Saktimudrika (It was a kind of ring looked like a snake's hood).

Signet ring looked like a bluster of Kusagrass.

Copper seal cum ring was used by the poor section of society. The archeology also proves that bronze metal was used for making rings as the same have been found from West-Bengal.

**Waist Ornaments:**

The women of this period were very fond of waist ornaments. The males also adorned their waists with jewelled ornaments. These were of various types. Such as the following:

Mekhală or Kaṭisūtra, It was an ornament of great importance having jewels and decorative tassels and festoons.

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hanging up to the knees in front. Its notable varieties were:

i) Kaccha

ii) Kanci

iii) Rasana

Kardhanī: It had one or more gold chains and some times a girdle of the strands.

Girdles:

These were tied around the waist by males and females. Elaborate girdles having a kīrtimukha clasp in front were made as shown in the images. Sometimes these clasps were ornamented with other patterns like four petalled flowers. Variations of girdles included 1) elaborate girdles with intricate designs which suited the females and added to their charm because the strings of these girdles had small

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1. TM, P-80; Samayamātrakā, 1. 14; III, 37; VI, 6, Sharma, B.N. op.cit. P-93.
3. NM, 41, 119.
5. KSTS, P-157.
bells which made jingling sound\(^1\). Girdles of delicate design which were studded with precious stones and were usually worn in wedding ceremonies\(^2\).

Waist bands or belts: (Ornate and decorated)\(^3\) and belt of gold was used by both sexes\(^4\). Women wore Saptaki and Sarasam\(^5\) whereas were wore Srnbhalam\(^6\).

**Nose ornaments:**

Nose ornaments (nose rings) were very popular in Northern India specially in Rajputana. The sculptures of Bhuvaneshvara, Khajuraho and other places also indicate their use. A nose ornament with ornamental design, made of gold, has been found at Sultanganj, Distt Bhagalpur\(^7\).

**Ornaments of ankles and feet:**

Like other parts of the body, ankles and feet also were adorned with the ornaments of different types. These were:

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2. *KB*, P-241; *Srṅqāra Sātaka*, 71.
4. *TM*, PP-232-233; *Bagh caves PL.F.*
Jingling nūpusaras: These were worn by the ladies and they produced pleasant sound. Rhythmic varieties of nūputras were I) Manjira and II) Kanira.

Mudrikā: It was a kind of ring worn on the second toe.

Anklets: The women of that period used to wear anklets on their feet. Their varieties were:

- Anklets with beads of lapis-lauzils;
- Anklets with bells set with precious stones (diamonds, pearls, emeralds, rubies, etc.);
- Jewelled anklets;
- Anklets with subtle designs;
- and Circular anklets with tinkling jewels which were used by the princely families.

1. TM, P-226; Kāvyamimāṇsā, P-17; Paivalacchānāmamālā, PP-14, 17.
2. Mānasollāsa, xxx. v. 1126.
3. TM, PP-226, 368; KM, P-23; Kāvyamimāṇsā, P-8; Mānasollāsa, vv. 1118-25; RT, I, 206-09; Bhārtiya Vidyā, XVII, PP-130-146, AI, I, P-181, AI, P-181; SAMARAICAKAHĀ, PP-75-78, Bagh caves, Pl.F; AMK—Introduction, P-24; Deopārā inscription, v, II.
4. Sāmayatrākā, VII, 14-17; Yasas, PP-397-399.
5. KM, PP-12, 30, 36; Ramacaritam, III, P-73, Privadarsīka, P-50.
6. HCCIT, P-83; KR, P-241.
7. Ajanta Paintings, Pl-10.
8. KR, PP-85-86; Candisatakā, VI, 11.5, P-273; Ryder, D.C. P-159; Sāmayamātrākā, VII.
Miscellaneous ornaments:

Mirrors were very important for the toilet. These were made of gold, silver, lead, iron and brass. Mostly brass served the purpose of mirrors.

Combs

Combs were also made of gold, silver, copper, brass etc. Besides, men and women royal animals such as horses and elephants were also bedecked with ornaments. For example accouterments of gold were for horse and girth decked the elephant. Chains, and bells of different metals were also used for decoration of animals.

II TECHNIQUES:

The techniques of making various types of metal articles can be studied under the following subheads:

1. Material used:

For making objects of war, agriculture, household and ornaments, various types of metals were used. Contemporary
literature reveals the fact that metals like iron, copper, silver, gold and bronze etc. were utilized for making different kinds of objects. Gold, silver, copper, tin, lead, zinc and iron were seven pure metals and the other metals were derived through specific admixture of the metals. Gold, silver and other valuable metals were used for making jewellery; Copper, brass, bronze etc. were used for making utensils, images, plates etc. Iron was used for making implements of war and agricultural instruments generally used for land grants and other such objects. It is noteworthy that objects of iron and copper such as nails, arrowheads, spearheads, daggers, hoes, locks and copper antimony rods were found at different sites excavated in Northern India.

Metal wise description of the material used for manufacturing metallurgical objects is given below.

Iron:

It was the most important and useful metal for making production and manufacturing instruments/tools for irons-

miths, carpenters, sculptors architects and farmers. The iron pillar at Dhāra, the capital of the Parmārs was the greatest achievement of the ironsmiths in the early medieval period. Though this pillar is now broken in three pieces, yet it seems that its original length at the time of its installation was only a little short of 50 feet. This reveals that it was the tallest of its type in the world. Excavations at several places like Pahārpur, Antichāk, Delhi, Kalibanga etc. have excavated various iron objects belonging to the period under study. From Bihar, iron nails, Daggers, hoes of the Muslim period and from Madhya Pradesh iron arrowheads, spear-heads, nails etc. of the period c- 6th to 12 century A.D. were recovered. Iron ore, furnaces, crucibles and slags were excavated from Delhi. Thus iron was the most useful and durable metal which played an important role in the economy of the period under survey.

Qualities of iron:

Many qualities of different grades of iron were in existence. Bhoja in his Yuktikalpatru gives a detailed description as under:

1. **TSPC**, I, 852, P-30; **KM**, P-64; **Yuktikalpatru**, P-80.
1. Krounca iron was two times better than the simple iron,
2. Kalinga iron was eight times better than krounca,
3. Bhadra iron hundred times as good as Kalinga,
4. Vajra- a hundred times better than Bhadra,
5. Pandi- a hundred times better than Vajra,
6. Niranga ten times as good as Pandi and
7. Kantha iron is million times better than Niranga.

These gradations of iron clearly refer to the following kinds of iron: a) Pig iron b) Cast iron c) Wrought iron.

Cast Iron was further classified as under:

i) Mridu: It was easily malleable but unbreakable and glossy iron.

ii) Kuntha: It expanded very little after hammering.

iii) Kadra: It was breakable iron.

Mines of Iron:

It is necessary to know the places where the ore iron has been discovered. Mention of the iron mines in the land-grants and the description of Akaradhikarapuhasas who were

1. Rasartnasamuchchaya, V, vv 71.72.
2. Majumdar, B.P. op.cit. p-200.
the officers in charge of mines suggest the existence of mines in abundance\(^1\). Mines were located in the middle regions of Beas and Satlej rivers.

**Copper:**

It was also a very important metal which played a vital role in the economy. Various types of articles, domestic utensils, coins, plates, inscriptions and a large number of images were made of it\(^2\).

It had two compounds (1) Sulphide (2) Sulphate. Varinda (c 900 A.D.) has described that sulphide of copper could be prepared artificially. Sulpher, copper and pyrites were to be pounded in a crucible, mixed with mercury and roasted and the product thus received was to be administered with honey\(^3\). Chakarpāṇi also mentions the method of manufacturing powder of copper compound. Blue vitral and borax contained copper and the method of extraction has been described in Rasaratnasamuchchaya. References to coppersmiths in Multan also reveal the existence of copper in use\(^4\). From Archaeo-

1. RT, IV, 39-41; EI, XI, P-22 fn. IV, P-157 fn; Yuktikal- patru, P-170 vv 24-29; AP, P-475, 21-22.
4. HIED, I, PP-28, 35.
logical excavations a large number of copper plates such as Niddhanpur copper plate grant, Dhukela District Copper plate grant and copper plate inscription of the Kalchuries, images in huge quantity, weights, saucerpans, frying pans, spoons, coins etc. have been found.

Mines of copper:

Copper was dug from the mines of the Mlechchha country situated in the north-west provinces. Hieun-Tsang had observed copper mines in the District of Kulu in 7th century A.D. He has also mentioned that Bhrahmpura (British Garhwal) and Kumyun were the copper producing countries. A superior quality of copper was found in Nepal. Dhatumanjari which forms a part of Rudrayamalatantra gives the names of countries containing mines which are: Nepal, Kamrupa, Bengal, Madanīśvara, Gangāvara (Himalayan foot step), the countries of the Mlechchhas, Ruma, the country of the Phirangas and the mountainous regions. Mines of copper were also found in the middle areas of Beas and Stalej in a large number. Thus copper has been found from various sources. It was mainly used for making copper utensils of daily use. Copper coins


of various dynasties and large number of copper plate grants diffused throughout the country were themselves the proof of highly flourishing state of copper industry. The numerous coins of copper issued by the various rulers of Northern India have been found from various excavations. For example 3900 copper coins of Kalachuris of Ratnapura have been found at Nauza Dhanpura (Madhya Pradesh). Many copper coins found at Rohtak testify that the copper currency was in use between Sutlej and Delhi and also formed the common currency of Punjab and Rajputana in the period between 500 to 800 A.D.

Gold:

It was mostly used for making ornaments as Indians have great love for jewellery from a very early period. Indeed, perhaps no people in the world have loved jewellery so much as the Indians. Both the sexes were very fond of wearing gold ornaments. Not only the royal and nobles but the common folk also had great fascination for ornaments and chose them according their means and status. The fashion of ornaments changed from time to time and the goldsmiths had always a busy time and an opportunity to show their skill and workmanship.

1. Coomarswamy, A.K. - Arts and Crafts of India and Ceylon, P-149.
MINES

Gold was obtained from the earth as well as from the rivers. In Assam, a section of the populace earned its livelihood by washing and extracting gold from water of the river from earliest times to the British regime. Places of gold product were seen by Hieun-Tsang. Mines of gold existed in Kulu Distt, in the kingdom of Rahma, Mayurbhanja, Darul and Udyam in north western region, Takka (situated in the middle of Beas and Satlej rivers), Mount Meru and Jambunada (Sona). The rivers in Kamrupa also contained dusts of gold. It could be produced by blending different kind of chemicals.

Types of gold:

Gold had two types: 1) Kosā or Kosha or Hiranya which was wrought gold and 2) Hema which was unwrought gold.

Purification of Gold:

To determine the purity of gold, the goldsmiths liquified it on the fire. The partials of ashes flew hither and

2. BRWW, I, P-177.
3. Ferrand, 43, 104.
4. CMI, PP-72, 76, 85, 87.
6. KKS, IV, P-69.
thither from the small oven\(^1\). After liquified gold got cooled down it was cut into pieces and tested on the touch stone for its purity.

**Silver:**

Silver, like gold, was also a precious metal mostly used by the common folk, nobles and rulers in the form of jewel-lery, utensils and coins. The common ornaments were girdles, kundalas, necklaces, bracelets, earrings and ornaments of feet (Anklets)\(^2\).

Silver vessels were also made for the Kings and nobles such as cups, dishes, trays etc\(^3\). Silver images of gods and goddesses were also made\(^4\). In the Somnath temple, there were many silver idols. Mahammed Bakhtiar is credited to have seen numerous silver idols in a temple in Kāmrūpa. Kalhana also describes idols of silver, preserved in temples of Kashmir which were utilized by the rulers to tide over

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financial difficulties¹. The literary sources and the excavations prove that Silver coins were in vogue during the reign of rulers of Northern India during the period under study². The Kings of Northern India had issued various types of Silver coins. A number of these coins have been attributed to the Mukhari rulers. Silver Drammas are found in abundance which were issued by Pala and Sena rulers. In Rajputana, Gujrat and Kanauj various types of silver coins were issued from 8th to 12th century A.D.

Mines:

There were many silver mines in India. The Muslim writers mention silver mines in the kingdom of the Gujaras. They also testify that mines of silver definitely existed in the kingdom of Rahma³. Silver mines existed in Uddyan and Darul areas in north eastern region and the areas between Satluj and Beas. Kulu District was also connected with silver⁴. These mines helped silver industry to flourish.

¹. RT, VIII, 991, 993.
². JRAS, 1906, P-843 fn; JNSI, X, P-28 fn, XV, P-214 fn; CCIM, P-239; IA, (1973-74) P-29; ASIAR, 1927-28 P-105.
³. Ferrand, 43, 104.
⁴. BRWW, I, P-177.
Bronze:

It was an alloy of copper and tin (eight parts of copper and two parts of tin) as described in Rasaratnasam-uchchaya. The quality of bronze, made in Surashtra (Surat) was excellent. The reference to braziers in epigraphic record reveals that the bronze-Casting functioned as a viable industry during this period. A large number of images of bronze, found in various parts of the country reveal that this industry had developed to a considerably high degree. In Bhatara copper-plate of Govinda Kesāva, description of Kām-syakāras (workers in bronze) has been given which shows that they had become economically sound and were in a position to donate houses also. It clearly shows that Bronze objects were in great demand and the bronze industry had progressed very much. Bronze was used for making household vessels like other metals. The excavations at Hansi, Distt. Hissar (Haryana) had unearthed a copper jar containing 57 bronze objects of 7th-8th century A.D. It is evident that dishes

1. EI, II, 9, 15, 30. IA.
3. EI, XIX, 277. fn.
were made of bronze and other articles i.e. ornamental vase-stands, bowls, Jars and cups of different patterns with ornamental bowl lids were also made of it.

Bronze bangles, necklaces, ear-ornaments and diamonds were also found. The recent excavations at Kumrahār have unearthed a few ornaments in bronze with lotus and wheel designs.

Mr. V.A. Smith has collected a list of the very small number of bronze implements found in India. Six authentic bronze implements were: one flat celt, one so called sword, one spear-head and three harpoon heads. Bronze casting was an important activity for making objects. During the Pala period, artists manufactured metallic pieces in Bengal and Bihar. Bronze was the standard metal for casting images. Technically, it was known as 'aṣṭadḥātū' (an alloy of eight metals). Dhīmān and his son Vitāpāl were the celebrated and talented artisans who were experts in casting metal images during the reign of Devpala and Dharampala, Kings of the

1. Report on Kumrahār excavations, P-130.
2. 1905, P-240, 1907, P-53. V.A. Smith - Indian Antiquary.
Pāla Dynasty. The skill and artistic beauty of the bronze images and other objects discovered at Nalanda, Kurkihāra and other places of Bihar, now kept in the Patna and Nalanda Museums, are the rare specimens of the art of bronze casting which had much developed. The noteworthy examples of bronze casting are i) a two-armed image of Avalokiteśvara from Nalanda on an elaborate throne and ii) a four-armed image of this very god from Kurkihāra.

Bell-Metal (Kāmsya)

This metal contained a greater percentage of tin than bronze and was used in making utensils, images, badges, coins, plates etc. Musical instruments which were prevalent in Ancient India such as Kāmsya-Tala were made of it. Saurāstra was famous for its bell-metal.

Brass

An important alloy of copper mixed with zinc was called Brass. The modern name 'Pittala' originated at a later date.

1. ASIAR, 1921-22, P-104; JBORS, XXX, P-159.
2. IA, XLI, P-20; EI, II, 9, 15, 30.
3. JISOA, II, 91934) PL. XXXV (Patna Museum Arch. No. 9786.
For example, in Rasaratna-samuchchaya brass is named as 'Pit-tals' and divided into two classes 'Ritica' and 'Kakatundi'. Mention is made in inscriptions about 'Pittalahāra's (brassmakers)'. It was an important metal as many house hold utensils of daily use of the common people were made of it. The sudras used to take food in brass vessels. Brass ornaments were also made which fulfilled the needs of the poor people. It was used for making images of various gods and goddesses. The most remarkable work was an incomplete Vihara made of brass, built by Raja Silāditya. In Nalanda there was a pittala image of Buddha about eighty feet high. 

Billion:

It was a base-metal and was an alloy of silver with copper, tin or the like. It was used for making coins which can be traced in the coinage of many Northern Indian dynasties. The Tomara of Ajmer and Delhi, Madan Pala of Gahadavala dynasty, Somesvara and Prithvīrāja had issued bullion coins. Dillivals coins issued by the Rajput rulers

1. Rasaratna-Samuchchaya, V-192.
2. HIED, I, PP-28-35; EI, IV, P-153 fn.
3. HDS, IV, PP-326, 342.
4. Majumdar, B.P. op.cit., P-203.
5. BRWW, II, P-174; LHT, P-119.
7. CCIM, PP-256-257 fn.
resembled the bull and horseman type coins, made of bullion which remained in circulation until the 12th century A.D. The early Muslim conquerors had adopted these coins.

**Steel:**

It was a very strong metal, used for making various types of weapons such as swords, spear-heads, blades etc. Steel (Tiksna) had six varieties which were i) Khara ii) Sara iii) Hrinnals iv) Tarabhaṭṭa v) Vajira and vi) Kalalauha. It indicates that iron industry in North India was highly developed. Mention of white swords points to the best steel swords. The idol of the Somnatha temple was made of bright steel, as attested by Muslim writers. Useful objects of domestic use were also made of it.

**Tin:**

It was a pure metal and Kāṁsyā was made from the combination of tin and copper. The proportion for making Kāṁsyā has been given in Rasaratnassamuchchaya. Eight parts of copper and two parts of tin were used in making this alloy.

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1. HIED, II, P-33.
It was used for making armlets. Vanga was its synonym which shows that South West Bengal was its find spot and Bihar imported it from this place. Numerous bronze images found in Bihar indicate that there were copper and tin minerals in the hills of Chhotanagpur.

Teon-Shih:

It was compound of equal parts of copper and calamine (Silicate of zinc and was the natural product of the country. The find spots of this alloy were kin-Lut-to (Kulu Distt.) And Brahmupura which were visited by Hieun-Tsang during his travels.

Mixed Metal:

There were seven pure metals (gold, silver, copper, tin, lead, zinc and iron) while the other metals were derived through their specific admixture. The compound of gold, silver and copper was used for different kinds of decorative work. Usually the coins were made of these metals but mixed metals were also used. For example, when gold became rare

1. ARM, II.17.
2. BRWW, I, P-177.
3. Ibid, P-198.
then it was mixed with baser metals. The Karkota type coins (625 A.D.) were the mixed metal coins. Gold Dinars were always more or less alloyed with silver.

Purification of metals:

For the metal industry it was very essential that the artisans should have the knowledge of melting, purification and tempering of different metals. So the people of early medieval period were not only aware of the art of making various articles of metals but were also well conversant with the method of purification of metals.

Alberuni has described that great knowledge of purification of gold, silver, mercury etc. had been gained by the people of that period. Sh. P.C. Ray in his book 'History of Hindu Chemistry' has discussed at length the purification of iron⁴. The Kashmir manuscript of Varinda (c 900 A.D.) also stated that at first iron was lighted and then macerated in the juice of the embolic myrobalan and trevia nudiflora and exposed to the sun. Again, it was macerated in the juice of certain other plants and then was rubbed in a mortar.

Chakrapāṇi of the 11th century A.D. has prescribed a better method of purification of iron. He mentioned that after

rubbing the iron bar with impalpable powder, the iron was to be heated to fusion point and flunged into the decoction of the myrobalans and roasted repeatedly in a crucible. A piece of iron is rubbed with cinnabar weighing 1/20th of the weight of that iron and lemon juice and sour gruel and roasted in a covered crucible forty times as informed in Rasaratnasamu-chchava. Tikṣāṇa (steel) iron can be powdered if it was heated repeatedly. Tempering of steel is a manner worthy of advanced metallurgy. It was a process to which the medieval world owes its Damascu sword. According to Agni-Purāṇa, iron was purified by saline. Alberuni has stated that the people of that time were well acquainted with the purification of iron, gold, silver and mercury etc. This view has been supported in other works also.

Copper was made pure by acid and Kāṃśya vessels by saline. Articles of gold, silver, precious stones purified by simple wash of water.

1. Ibid., PP-62-63.
2. Rasaratnasamu-chchava, vv. 113-114.
4. Dr. Mahesh Singh - op.cit. P-252.
There is some variation in the purification of polluted pots and vessels as the Mitaksara on Yājñavalkyasmirīti (1080-1100 A.D.) remarks that it is not the absolute rule that copper must be purified by acid alone. A passage in Suddhi Prakash explains the process of Patrasuddhi (cleaning of polluted vessels) in Medieval India.

III TOOLS AND INSTRUMENTS:

The metal workers needed various types of tools and instruments for giving the desired shape to the metal. First the ore-metals were melted and mostly iron was made to undergo this step because it was the metal most overwhelmingly used. Implements of agriculture such as plough, spade etc. were made of it. Other implements of grass-cutters, barbers, tailors, carpenters, fishermen, hunters and other professionals such as sickles, scoops, razors, needles, nails, scissors, saws, fishhooks, nets and other useful implements were also made of iron. The commonly used implements of blacksmiths, goldsmiths, coppersmiths, silversmiths etc. were:

1. HDS, IV, P-326.
Narchi or eshanika:

It was a scale used by the goldsmiths\(^1\). 

Hammer:

It was an instrument used for making various types of iron objects. Beams of iron used in buildings were made by this\(^2\).

Bellows:

These were made of leather and the blacksmiths used them to fan the fire in heating metals\(^3\). 

Pincers:

It was an instrument used by the goldsmiths. In the archaeological finds, the implements used in different crafts such as smithy, pot-making, gold work etc. were found\(^4\). One room yielded a complete set of the goldsmith's tools. These included.

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3. TSPC, 113, P-97.
i) Pincers ii) a pair of tongs iii) a small hammer iv) A tripod v) Touch-stone with marks of gold testing. v) Spades and shovels (Khanitra): These were iron made instruments, used for digging out the minerals.

Iron Mortar:

It was used for making crucibles.

Furnaces and Oven:

There implements of Pala period have been found from Nalanda, Kurkihara and Chandankeyar. These tools involve good degree of familiarity with metallurgy and clearly prove that the metal workers who made them were quite adept in the process of melting, casting and other activities concerning metallurgy.

The Process of making Metal Objects:

For making metal objects, the ore-metal was obtained from mines, rivers etc. Some alloys were got by mingling two or

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4. Ibid, P-11, 37, fn; Patna Museum guide P-3560.
5. Sinha, B.P. op.cit.,
more metals. For instance Kāmsya (bronze) was prepared by mixing eight parts of copper and two parts of tin with brass was made by heating together copper and zinc.

These ores were crushed and powdered and were subjected to several washings and then melted at the first stage. Generally, the furnace was formed of refractory clay and was in a truncated pyramid. The arrangement for a blast of air with two bellows was made at the bottom.

Smelting:

The furnace was filled with lighted charcoal which was raised to its full heat. The washed ore was put in the furnace and bellows were used to fan the fire until the fused "regulus" formed a pool at the bottom covered with a layer of used slags. After cooling it down, crude metal was removed.

Roasting:

Crude metal was now kneaded with cow dung into small balls and was dried in the sun. It was then roasted in a shallow furnace formed a ring of slag cakes placed on edge.

Refining:

The roasted metal was refined in the first furnace. Charcoal completely reduced the metal. The refined metal was
collected at the bottom and then brought out. This method was adopted for getting pure metals out of the ores, which were used for making various types of objects. Even the forged weapons, were sharpened in the fire of charcoal by the ironsmiths.

Iron beams were also made on a large scale and these were used in the construction of buildings.

Casting of metals:

The art of metal-casting was also an important work of that age and Bronze-casting had its first place in this art. The discovery of numerous bronze and octo-alloy images in different parts of the country, in later times suggest that this industry had developed to a high degree of perfection. The reference to braziers in an epigraphic record reveals that the bronze-casting functioned as a viable industry during the period under study.

The presence of lumps of copper ore suggests that the melting and casting operations were done on the spot. The discoveries of a series of oven marks within the boundary of

1. Nalacampu, Iv, P-206
2. IA, XLI.P-20; EI, II, 9, 15, 30, EI, XIV, P-199.
3. Neogi-Copper in ancient India, P-21; Smith, V.A. History of fine arts in India and Ceylon, PP-171-172.
the Nalanda ruins also proves the existence of this art. The gigantic copper colossus of Buddha image of about eighty feet in height\(^1\) is indicative of the well advanced technology of metal-workers. Dhimān and Vītāpāla were experts in melting and making of metallic images as described by Taranath\(^2\). The finish, craftsmanship and artistic beauty of the bronze images and other objects found at Nalanda, Kurkihara and other places in Bihar now preserved in the Patna and Nalanda Museums) prove that the art of bronze-casting was at its acme during the period under survey\(^3\). It is noteworthy here that at Nalanda Temple site No.13 an interesting brick-made structure identified as the melting furnace situated to the north of the main structure has been found\(^4\). The furnace was made of four channels in one square divided by short walls, each of the chambers being provided with two flues for the fire to burn and air to pass. The discovery of a metal furnace with the metal pieces and slags in it, undoubtedly proves that the metal objects were cast at Nalanda. A four armed bronze image of Balarāma belonging to

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1. LHT, P-174, ii.
2. ASIAR, 1921-22, P-104; JBORS, XXX, P-159.
3. All Kurkihāra images bear inscription of 8th-9th century A.D. (Proceedings of 7th oriental conference, P-798).
the time of Devapāla has been discovered at Kurkihāra. The cast image of Vishṇu is also a magnificent example of Indian art¹.

Techniques of making Alloys:

The art of preparing alloys like Kāmsya and Vartaloham was known to the workers². Kāmsya was prepared by melting eight parts of copper and two parts of tin, Pittals (brass) was got by mingling copper and zinc³. Vartaloham was obtained from Kāmsya, Copper, pittala, iron and lead. The Bhatera copper plate of Govinda Kesva has mentioned the name of one Govinda who used to make bell-metal (an alloy of eight metals). In this plate, Kāmsyakāras (workers in bronze) have been described to have grown very rich⁴. The discovery of numerous bronze and Octo-alloy images in different parts of India suggests that this industry had developed to a great extent. Even gold could be made by blending different kinds of chemicals⁵. The alloys were used to make

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1. Sahai, Dr. B. and French, J.C. - The art of the Pāla Empire of Bengal, P-42.
2. Rasaratnasamuchchaya, I, P; KKS, 87, P-214.
4. Ibid.,
5. KKS, IV, P-69.
utensils, images, badges, coins, plates etc. Only the worker who had acquired high technical skills could make such articles.

Technique of Welding:

The metal workers had knowledge of welding also. Utbi, makes a mention that welded beams were used in the construction of houses and temples in Mathura. About 239 beams ranging upto 17 feet long and upto 6" by 4" or 5" by 6" section have been used in the Gundichabari at Puri. Graves had found the largest beam which is 35 feet long and 7" to 7" square. The larger beams were produced by welding together a number of blooms of wrought iron by means of a hammer. It shows that the technique of welding was known and used by the metal workers.

The Technique of putting Gold on Copper:

This technique was applied by the clever workers. During the reign of king 'Kalan' (1063-89 A.D.), the artisans were well versed in the technique of gold plating on copper. By

2. RT, I, 311.
this procedure the objects of copper looked like those of gold and one could be deceived easily. The technique of gold plating during the period under study had much advanced.

The Art of Engraving:

Engraving were also made on the vessels. The names of Kings were engraved on various metal objects. The Marks of the names of bygones Kings had been found on the big silver bowls. The engraving of alphabets was done on the metal plates and on the pedestal of images. Mostly royal records were engraved on the copper plates by the artists (smith) which were given to the Brāhmaṇa in donation. Magadhan artist, Someśvara was a skilled artisan in inscribing the Praśasti by means of a division of letters. Other artists who engraved the Praśastis on the plates were Palhaṇa and Nāgavarma. The sculpture and coins of this period also show that the art of engraving had attained much refinement. For example a number of gold coins found in Bengal reveal high degree artistic sense and technical skill in their engraving.

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1. Ibid., 187.
2. EI, XIII, P-42; XIV, P-428; XX, P-13; XXVI, P-263, I, PP-81, 147; Silimpur inscription v. 29.
3. Allan, J. - Catalogue of coins, P-C XXVII;
Modeling:

In 8th century A.D. (early Pāla period) the classical ideal had been followed in modelling a figure. A new era had begun in the realm of art with the advent of the 9th century A.D. which bequeathed a number of images found from Nalanda, Kurkihara and other places. The figure is rather stiff and roundness is visible in the treatment of various limbs. Another feature is the thickness of figure which gradually becomes heavier afterwards. The modelling of the figure attains quite roundness and a weightiness lends power to the image. In this procedure the tendency of giving movement in the front of backward and in the joint of the body are clearly noticed. The image of the standing crowned Buddha from Kurkihāra (now in Patna Museum) is an example of fine modeling.¹

Rubbing, Sharpening and Polishing:

Contemporary literature has references to sharp, beautiful and strong objects. For giving finishing touch to the artifacts and making them smooth, the rubbing technique was used. The metal workers knew the technique of sharpening also. An ironsmith, after having forged weapons, used to

¹. Bandyopadhyay, Bimal - Metal sculpture of Eastern India, PP-26, 27, 38.
sharpen them in a fire of charcoal.¹ Double edged swords of Bengal were very sharp like the Anga and Vanga swords.² Anga swords were famous for their sharpness, strength and excellent handles.³ Metal objects were subjected to polishing also in order to make them attractive, shining and beautiful. According to Bāṇa swords were so finely polished that they could be used as mirrors.⁴

The Technique of setting jewels and precious stones in ornament:

The literary as well as the archaeological excavations reveal the fact that the goldsmiths very well knew the technique of setting jewels in ornaments. Precious and semi-precious stones were used for making jewelled ornaments and utensils. Raw and uncut stones were cut sharply to set in gold or silver plates and properly polished. A high degree of perfection in the cutting and polishing of stones was prevalent during this period. Dandin mentions the use of rice husk by jewellers for polishing gems. Heating and cleaning technique was used for giving brightness and shine.

1. Sāstri Pandit Vishvanāth - Vikramāṅkdevacaritam XIII, 39, P-357.
2. AP.(Vangabasi), 245, 21-22, P-475.
3. Peterson, P. - Sarīṇadhara-Paddhati v. 4676.
4. HCCT, P-109.
The goldsmiths also knew the technique of melting old ornaments and then to give them new shapes. Sometimes, the old ones were polished or brightened.

Techniques of Designs:

Metal workers were not only aware of the art of making various types of objects from metals (precious) but they also knew the technique of making numerous designs on them. After purification of the metal, different types of ornaments were made of it. The literature of the period has described the fine specimens of jewellery worn by the people such as armlets with fish and snake motifs¹, crescent shaped necklace,² neckbands of tiger claws interlinked with gold³ and ear ornaments with star, trident etc⁴. These reveal the master skill of the goldsmith who introduced novelty and variety in designs to meet popular demands of the people of early medieval period. The descriptions also record ornaments of various shapes.⁵ The noteworthy designs were as under:

¹ Kœ, P-16, K-10.
² Ibid, P-243.
³ HCCT, P-116.
⁴ Ibid, P-13; KB, P-13.
⁵ E I, I, P-92, VI, P-146; IX, P-288.
Floral Design:
Bendā was an ornament of forehead and very popular in the ladies. It consisted of a round pendant with floral designs worked out in precious stones.¹

Ketaki leaf Lotus shaped design:
This design was made on ear-ornaments. Manasollasa has referred to kundala made of gold with six or eight nemis, Katakas, tā-tankas used by both the sexes. Danḍaka, a circular ornament consisting of pearls was attached to it whose upper part had the shape of the ketaki leaf of gold.² It was called chuḍāmanḍana. Chuḍika was the name of its form when its upper part was made in lotus shape.

Carving on earrings:
Gold earrings set with jewels had sometimes a channel like a crooked line carved on them.³

Makara Designed Gold Armlets:
Makara designed Gold armlets were also made. Mālati had adorned her arms with this ornament while riding a horse.⁴

¹. KSTS, P-150.
². Manasollasa vv. 1102-03-1104-1105.
³. NC, XV, 41-42; VII, 62.
⁴. HCCT, P-262; KB, P-161.
Nine types of armlets having different designs were used by the females as clearly shown at Khajurāho.¹ Some images had been shown wearing sarpa-Keyūras.²

Leaf Designs:

These were the favourite designs. For example Tāliputa ornament had the specific design which had some resemblance with the leaves of the palmyra (Tali). Candrapīṇḍa had worn emerald set ear-ornaments which looked like full bloom siris flowers.

Crescent shaped design:

This design was also very popular and ornaments of this type have been referred to in the contemporary literature such as necklaces (crescent shaped) which were liked very much.³ The betel bearer of Kādambarī had crescent shaped ornament inlaid with pearls.

Lotus and wheel designs:

Ear-ornaments of these designs made of copper and bronze were in vogue. A few ear-ornaments of this type have been excavated in the recent excavations at Kumrahar.⁴

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1. KSTS, P-153.
2. NM, 61, 484; L-143; KR P-10.
Angada was a circular ornament worn on the upper arms and made of a thin rod of gold with its ends resembling a lion’s face. It was set with jewels and small strings with pearls and blue-manikās attached to it.¹ Chudak, was adjusted to the forearms and divided into two parts, each connected with the other by means of thin pins and studded with diamonds, rubies and pearls.

Decorative Design:

The women of this period were very fond of wearing broad bracelets with decorative designs. During Pala Period, the female figures have been shown wearing barrel-shaped bracelets with a cris-cross design which was commonly used.

Mekhalā or Kaṭisūtra had jewels and decorative tassels and festoons hanging upto the knees in front, when worn by the women around their waists (plate VII). Elaborate girdles containing a kirit mukha clasp in front were in use. These clasps were sometimes ornamented with other patterns like a four-petalled flower.² Chains of different kinds were made. Chains, studded with precious stones, hanging on the thighs,

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1. Mānasollāsa, vv. 1110-1113.
2. KSTS, P-157/
with their ends fixed with arrow-shaped four-leaved or trip coastal patterns, were in use. Different types of girdles, put on by the male deities have been seen on the images.

IV. IMPORTANT METAL INDUSTRY YIELDING SITES

In the field of metallurgy, Northern India had made a considerable progress. Literary and epigraphic records reveal a highly advanced stage of this craft. Numerous instances have been found regarding localization of this industry and some cities had become famous for it. Images of various Buddhist, Jain and Brāhmaṇical gods and goddesses, made of bronze and copper have been found from various sites such as Nālandā, Kurkihār, Chankankeyari, Varendri and Vesantgarh in Rājasthān.¹

Pahārpur, Antichāk and Kalibanga

War weapons of different kinds had been brought to light by excavations at Pahārpur, Antichāk in Bhagalpur Distt. of Bihar, Kalibanga in Rājasthān etc.² The weapons were swords, spear heads, knives etc.

¹ Catalogue of the Buddhist Sculptures in the Patna Museum, P-II, 37 fn; ibid, P-61 fn; Patna Museum guide, P-35 fn.
² MASI, 55, PP-85-86.
Benaras, Magadha, Nepal, Saurashtra and Kalinga

The sword-making industry was an important one and indigenous literature has mentioned various places of Northern India where swords of different types had been made. These were Benaras, Magadha, Nepal, Saurāstra and Kalinga. But according to Sṛṅgadhara, the famous centers were - Khati-Khattara, Rishika, Vanga, Surparaka, Videha, Madhya-magrama, Chedidesā, Sahagarama and Kālinjar. Out of these, the swords made at Benaras, Saurāstra, Rishika, Anga and Kālinjar could stand the test of time.

Bengal

Bengal was very famous for its double edged swords which were very sharp as described by Chau-Jukua.

Khattara, Anga and Vanga

Khattara was a place, famous for making beautiful swords while Surparaka swords were strong. Anga and Vanga were well known places where sharp swords were manufactured.

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1. Yuktikalpatru, P-170 vv 24-29; Sṛṅgadhara Paddhati vv 4672-4679.
2. Sṛṅgadhara-Paddhati vv 4672-4679.
4. AP, (Vangabasi), P-475, 245, 21-22.
5. Sṛṅgadhara-Paddhati v, 4676; AP, P-886.
Malwa

The women of Malwa wore numerous types of ornaments such as jingling nupuras and it indicates that this place had artifacts of different types made of different metals (gold, silver, copper etc.).

Thana

The following descriptions also speak about the places of metal industries: Thana was a part of copper goods in the time of Marco Polo; in Multan reference to coppersmiths have been found. Saurashtra was famous for Kāmśya (bronze or bell metal).

Sultan Mahmud had plundered various articles of precious metals and among them was one folding house of silver, measuring thirty by fifteen yards and a richly decorated throne reputed to be that of Raja Bhima of the Pandya dynasty.

1. IM, P-226.
3. HIED, I, PP-28, 35.
4. ARM, 11.15.
5. HIED, II, P-35 Niyogi Puspa, op.cit., P-238.
Gujrat and Kashmir

Somnath temple also had a numerous idols made of gold and silver. According to Kalhana in the temples of Kashmir gold and silver idols had been preserved and these were appropriated by their rulers to meet financial exigencies.

Mathura, Multan and Deccan

In a temple of Mathura, there were five idols of gold, five yards in height; the eyes of one of them were formed of two rubies and the eyes of another were formed of two sapphires. It has also been mentioned that the city of Mathura had a thousand houses on both of its sides and ideal temples were attached, all strengthened from top to bottom by rivets of iron beams. Kashmir had copper mines and Deccan imported copper from Kashmir, Multan and Saurashtra through water route. The find spot of tin was south west Bengal.

V. ROLE AND STATUS OF METAL WORKERS' S:

Along with the description of metals of different types, their way of extracting, refining, and procedure and tech-

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2. RT, VIII.
3. Tabqat-i-Nasiri, P-85.
4. HIED, II, P-44.
5. RT, IV, 615.-17.
6. ARM, II, 17.
niques of making various types of ornaments, utensils, war weapons, agricultural implements and other articles which were in use during early medieval period, the position of metal workers is also worth mentioning. The very casting of numerous iron beams and dowels to be applied in the north Indian temples speak of the high proficiency gained in the metallurgical knowledge. There are numerous copper-plate grants standing as witness by themselves, sometimes containing the names of the persons and specific work of the metal workers such as blacksmiths, coppersmiths, kamsyakaras, goldsmiths, with often their grades of proficiency like silpin, vaidaghi, vijananin and so on.¹ Brass smiths and rupkāras are also mentioned. Rājaśekhar also referred to lohakāra, suvarṇkāra and vaikatika (Jewellers) etc.

The gradual promotion in the qualifications, i.e. from an ordinary artisan (pitalahāra) to silpin, vijnanin and then to vaidagdhi has been mentioned in five inscriptions of Paramardi's reign.² Metals were an indispensable part of society and the people of all walks of life were in dire need of these. In different parts of Northern India, swords

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1. IA, XVII, 1888, P-236, 1, 48, P-227,i.p; Ibid, XLI, P-20 fn; EI, IV, P-153 fn; XX, P-131; XVI, P-9, 54; XXIII, P-291; Kāvyamimāṃsā, P-35.
2. Bose, N.S.-op.cit., P-150; EI, I, No. 16. v. 36.
of various types were made. Sculptures of this period also point to the flourishing state of making spears and swords. On the preparation of armoury, specially of swords, the King's Chieftains had their control. Feudal lords might have had their own armoury factories. Sukranitiśāra refers to the makers of armours as king's servants.¹ This shows that the armours worked under some kind of royal patronage or control.² In military exercise, the kings summoned the experts in the art of fabricating weapons described in mānasollāsa³. Then the expert having selected his opponent, exhibited his skill in using different weapons namely the short daggers, the sword, the bow, the discus, the spear and the mace. The iron smiths constituted the most important group of metal workers. The palas and the Senas in Bengal had large war fleets and the making of nails and chains and joining them took much of the energy and time of the blacksmiths.

Goldsmiths have been spoken of by Bana as Kaladah or Svargaśakaraḥ or Hemakāra who remained busy in making gold ornaments.⁴ At the time of the marriage ceremony of Rajy-

1. SN, II, 196-97.
2. TSPC, I, P-185, III, P-280.
4. HCCT, P-124; RT, VII., 928-931; Sharma, Dr. B.N. op.cit. P-340.
asri, a number of gold workers had been engaged in hammering gold. Both the male and female used various types of golden jewellery. The fashion of ornaments changed from time to time and so the goldsmiths had always a busy time to fulfil the requirements of the people. King Harsa had introduced many new types of ornaments such as golden ketaks, leafed tiaras, pendent and gold strings at the end of locks. Kashmiri goldsmiths also had attained a high standard in the art of making new fashion ornaments. The industry of making jewellery had provided livelihood to many of the metal workers as its flourished state had given employment to a large number of people. It is worth mentioning here that in Ancient India, the gold and silver ornaments were manufactured by goldsmiths but during the period under survey, the industry developed so much that the division between workers of the two metals became imperative. The plan of Anahilapur town reveals that separate streets were allotted to goldsmiths and silver smiths. Even for the minting of gold and silver coins, the Government assigned separate work-places. Barring the minting concern, the jewellery business was run independently and there were separate establishments for

1. RT, VII, 928-931.
gold and silver workers. As it was a lucrative industry involving extensive dealings with the public, the king had to exercise surveillance and get the tools of the goldsmiths examined from time to time.\(^1\) It was perhaps due to the use of tools that they could pinch gold in the process of manufacture under the very nose of their clients. Due to this, the ancient lexicons called goldsmiths as pasyatoharah which meant that he could rob one of ones gold in one's presence without letting one know about it. The literature and the sculptures of the period throw light on the large variety of ornaments used by both sexes. From this it is easy to infer that the making of jewellery had provided employment to a large number of workers. Goldsmiths had grown very rich and they had to pay tax to the king.\(^2\) It was said of one of the goldsmiths that he had grown so affluent that, whenever he came across a beautiful girl, he offered 500 gold coins to her family and married her. In this way he married five hundred girls and provided them all with all kinds of gold ornaments\(^3\). This shows that they (metal workers) had attained proper place in society and the economic condition of some of them was very sound.

\(^1\) SN, IV, Lokadharma, 43, P-243.
\(^2\) Ibid, Rajadharma, 322, P-322.
\(^3\) TSPC, X, VIII, 192-94, P-105.
Coppersmiths had also attained high position by making excellent artistic objects. A gigantic copper colossus of Buddha image about 80 feet in height is a magnificent piece of that developed technique. It indicates towards the talented and expert workers who were able to make such a huge image of metal.

The great artists called Dhimān and Uñāpāla were the makers of highly developed artistic bronze work of this period. The skill and artistic beauty of the bronze images and other objects found at Nalanda, Kurkihāra and other places of Bihar, now preserved in the Patna and Nalanda museums are evidence to the fact that the art of bronze-casting was fully developed. In the Bhatara copper plate of Govinda Keśava, Kāmsyakāra (workers in bronze) have been referred to as one who had grown so rich that they could donate houses. Blacksmiths, supplied agricultural implements and lived in the vicinity of cultivated areas as could be seen from signs of burning of heaps of wood and charcoal.

1. LHT, II, P-174.
2. ASIAR, 1921-22, P-104; JBORS, XXX, P-159.
3. EI, XIX, P-277 fn.
4. HCCT, P-277; Nalacampu, IV, P-206.
The epigraphs have reference to blacksmiths who worked on iron. The greatest achievement of the ironworkers perhaps was to have set up the famous iron pillar at Dhārā, the capital of the Paramārs. It is broken into three pieces, now but the length of the original pillar at the time of its installation was only a little short of 50 feet, thus making it the tallest of its type in the world.²

Thus, contemporary literature has referred to a large number of metal workers. They were a part and parcel of the society of that period and gained wide popularity. The community could not go without these workers. From the point of view both aesthetics as well as utility the objects fabricated by metal workers were of excellent quality. An important role in the society was its modern development to a considerable extent to the metal workers of the period under study.

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1. EI, IV, P-126; IA, XLI, P-20 fn.